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RESEARCH ON TEACHING METHODS WAS REVIEWED TO DETERMINE WHAT IS KNOWN ABOUT ACHIEVING EFFECTIVE TEACHING. EMPHASIS WAS PLACED ON EMPIRICAL RESEARCH, BOTH HISTORICAL AND CONTEMPORARY, RATHER THAN THEORETICAL INNOVATIONS. DISCUSSIONS WERE PRESENTED ON (1) COURSE CONTENT AND CLASS SIZE, (2) TRADITIONAL TEACHING METHODS OF LECTURE AND DISCUSSION EMPHASIZING STUDENT-CENTERED DISCUSSIONS AND INSTRUCTORLESS STUDENT DISCUSSION GROUPS, AND (3) NEW TEACHING METHODS (EXPERIMENTAL LEARNING, PROGRAMED LEARNING, INDEPENDENT STUDY, LABORATORY METHODS, AND AUDIOVISUAL AIDS). CONCLUSIONS INDICATED THAT THERE WAS NO ONE BEST METHOD FOR ALL GOALS, STUDENTS, OR TEACHERS, BUT THAT THE BEST METHOD IS A FUNCTION OF EACH OF THESE. INDICATIONS WERE ALSO MADE THAT THERE HAS BEEN CONSIDERABLE IMPROVEMENT IN THE MAJOR AREAS REVIEWED. AN IMPLICATION OF THESE FINDINGS INDICATED THAT ONE SHOULD EXPECT TO FIND A VARIETY OF TEACHING METHODS AND THAT TEACHERS SHOULD DEVELOP A VARIETY OF SKILLS. (RS)

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in Higher Education

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NEW DIMENSIONS
IN HIGHER EDUCATION

Number 16

NEW DEVELOPMENTS IN TEACHING

by Wilbert J. McKeachie

Everett H. Hopkins, Editor

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

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Nationally, Professor McKeachie has participated in committees of the American Psychological Association, Social Science Research Council, National Science Foundation, National Institute of Mental Health, American Council on Education, Association for Higher Education, and others dealing with goals, curricula, teaching methods, and facilities for higher education.

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FOREWORD

(If and when this manuscript is published for general distribution, the Editor will gladly prepare an appropriate Foreword for the wider audience.)

HIGHLIGHTS

1. A learning theory can suggest directions for educational research, but present learning theory does not provide prescriptions for immediate application to teaching.

2. Differing teaching methods make a difference in learning if one analyzes different goals of education. Other things being equal, for goals of retention, application, problem solving, attitude change, and motivation for further learning as differentiated from acquisition of knowledge, small classes are more effective than large classes, discussions more effective than lectures, and student-centered discussions more effective than instructor-centered discussions.

3. Different teaching methods are effective for differing types of students. This implies the use of a variety of methods if all students are to be taught effectively.

4. Research is needed upon the tactics of use of a variety of teaching methods within a semester and upon the sequence of teaching-learning processes involved in the day-to-day progression through the semester.

5. An implication of research to date is that the teacher needs a teaching situation which will permit him to vary his methods to meet differing goals, and to be effective with differing types of students.

I. INTRODUCTION[1,2]

"New" is the "in" word in education. Faculty members are hit from before and behind with "new" curricula, "new" media, the "new" learning theory, the "new" student generation, and presumably next the "new" faculty. If we fail to get with it and adopt the latest "new" fad, we are obviously mossbacked old fuddy-duddies who are opposed to the improvement of education.

Worst of all, most of us have a sneaking suspicion that our accusers may be right. We have so much trouble keeping up with even a portion of the scholarly field we teach that few of us can honestly say that we are well-informed on the "new" learning theory, the impact of the "new" curricula on campus courses, or the "new" media.

This paper is intended to review such questions as: What does research on class size show? What is the relative effectiveness of lecture and discussion? Is student-centered discussion more effective than instructor-centered discussion? What are the implications of principles of learning for teaching? Is there one best teaching method for all subject matter, goals, students, and teachers? In fact, is there one best teaching method for a particular course? What are the newer developments in college teaching?

I cannot give definitive answers to these questions, for research always uncovers new questions as it clarifies old ones. But I shall try to evaluate where we stand as of mid-1966--stating my impressions flatly and contentiously in the hope of stimulating further research and organizing this report around the major topics on which research has focused: class size, lecture, discussion, independent study, programmed instruction, laboratory methods, and audiovisual devices.

Although the last few years have been some of the most highly active in the history of research on college teaching, this recent research becomes more meaningful if it is viewed in the context of past research. Unless the researchers to date have been completely blind, no single variable accounts for a large part of the diversity in effective teaching. Rather, there are many variables which account for very small portions of this range in quality, and, to make matters worse, effectiveness often seems to depend upon the interactions of variables, e.g., a particular kind of teacher may be effective in a particular situation. It is thus unusual for an experimental variable to produce results that are clearcut even when the variable is important; it is only when one reviews a number of studies that one can safely reject the usual conclusion, "no significant difference."[3] Consequently, I shall review the historical antecedents of each major area of research besides discussing contemporary work. I shall emphasize empirical research rather than theoretical or "experimental" innovations which are as yet untested. After a brief discussion of the areas of course content (and its attendant instructor variables) and class size, the traditional teaching methods of lecture and discussion are considered, with an emphasis on such recent developments as student-centered discussions and instructorless student discussion groups. Reviewed among the newer teaching methods--those that particularly evolved during the past decade--are experiential learning, programmed learning, independent study, laboratory methods, and the extensive use of audiovisual devices.

The basic question researchers have tried to answer is "What kind of teaching-learning situation is educationally most effective?" This implies that the goals of education can be defined precisely enough to enable judgments to be made about which of two teaching methods is more effective. Unfortunately, statements about goals are often so general that judgments about teaching effectiveness can only be impressionistic. The ultimate criteria of teaching effectiveness are changes in students: learning and movement toward educational objectives.

Typically we attempt to measure these changes only over relatively long periods of time--such as a semester--and most research thus has explored the effect of a particular variable, such as class size or teaching method, doggedly imposed day after day for a semester. If professors have multiple goals for a course and if different methods are effective in achieving different goals, the effective teacher is one who has a repertoire of skills which he can use flexibly as his emphasis shifts from one goal to another during a course or even during a single class period. In the sections that follow it will be clear that I believe the evidence favors small-group discussion methods for achieving many of the most important goals of higher education. But this does not mean that the instructor should make a commitment to use only small-group discussion throughout a course. Rather, he should strive to set up his course so that discussions, lectures, films, and all the tools of his profession can be used effectively when needed.

II. COURSE CONTENT

In thinking about college teaching, professors have usually been most concerned about content. The Ph.D. has been the teacher's certificate for working at the college level. It seems obvious that knowledge of subject matter should be necessary (but not sufficient) for effective teaching. This assumption, however, has never been checked, and conceivably students might be better educated by a confused or ill-informed instructor who motivated his students to clear up the confusions than by a professor with great depth of knowledge.

The whole area of content has been neglected in research on teaching.[4] What is the relationship between the instructor's learning skills and his ability both to teach these skills to students and to motivate students to learn? We do not know the effects of misinformation, amount of information presented, level of abstraction, emphasis upon cognition vs. motivation, analysis vs. synthesis, didactic vs. problem-solving approaches, or deductive vs. inductive styles. Fortunately programmed instruction is beginning to give some attention to these variables.[5]

One can imagine that proposals for research into professors' "knowledge of subject matter" would not be greeted with enthusiasm by professors. Thus, it is not surprising that the beginnings of research on teaching have been in areas which are less personally threatening.

III. CLASS SIZE

The question of class size provided a useful and impersonal base for research on teaching. Are small classes really more effective for teaching than large classes? The professor's answer has generally been "yes." But the refreshing empiricism of the twenties looked hard at many "self-evident truths" about human behavior: among them was the assumption that class size had something to do with educational effectiveness.

Among the first investigators were Edmondson and Mulder[6] who compared the performance of students matched for intelligence enrolled in a 109-student class with students enrolled in a 43-student class of the same course in education. Achievement of the two groups was approximately equal, with a slight edge for the small class on an essay and the mid-semester tests, and for the large class on quizzes and the final examination. Students reported a preference for small classes.

The Edmondson and Mulder results at Michigan encouraged the Committee of Research of the University of Minnesota to begin a classic series of studies of class size. In 59 experiments involving such widely varying subjects as psychology, physics, accounting, law, and education, the results of 46 favored the large classes. Although only eight differences were large enough to be statistically significant at the 5 per cent level, six of the eight favored large classes.

Support for small classes, however, came from studies in the teaching of French conducted by Cheydleur[8] at the University of Wisconsin between 1919 and 1943. With hundreds of classes ranging in size from 9 to 33, Cheydleur found a consistent superiority on objective departmental examinations for the smaller classes. Mueller[9] found similar results in an experiment comparing elementary psychology classes of 20 and 40 students. More recent experiments are also favorable to small classes. Nachman and Opochinsky[10] found a small class to be superior to a large class on surprise quizzes, but the two classes were not significantly different on the final examination for which students prepared.

In the Macomber and Siegel experiments at Miami University[11] significant differences favoring small classes were found on measures of change in misconceptions in psychology, on a case test of problems in a course in marketing, and on measures of student attitudes toward all the courses. When retention of knowledge was measured one to two years after completion of the courses, in eight of the nine courses compared, small differences favored the small class (Siegel, Adams, and Macomber).[12] Differences were also revealed in the more subtle and persisting results of Feldhusen's[13] study showing that a small class in educational psychology produced more change in attitudes toward teaching than a large class.

Few of us are satisfied with the achievement of knowledge if it is not remembered, if the student is unable to use it in solving problems where the knowledge is relevant, or if the student fails to relate the knowledge to relevant attitudes. If one takes these more basic outcomes of retention, problem solving, and attitude differentiation as criteria of learning, the weight of the evidence clearly favors small classes. Moreover, in almost all studies, students and faculty members tend to prefer small classes. Other things being equal, one would opt for high student and faculty morale.

But it is economically impractical to teach entirely in small classes. If we are to make wise decisions about when and where small classes are most important, we need to analyze more carefully the changes in educationally relevant variables associated with changes in size. One lead comes from social psychologists Thomas and Fink[14] who have reviewed research on face-to-face groups--not only classroom groups, but laboratory, business, and other groups. They suggest that two types of input increase with increasing group size--resource input (skills, knowledge, etc.) and demand input (needs). It is clear that the larger the number of group members, the greater the likelihood that some members will have resources of knowledge, intelligence, or other skills needed for the educational purposes of the group. It seems likely, however, that there is a limited amount of relevant knowledge and skills, so that beyond some point additional students contribute little that is not already part of the group's resources. A group's utilization of resources is constrained by the simple facts that (1) in a large group a smaller proportion of group members can participate orally and (2) the larger the group, the less likely it is that a given person will feel free to volunteer his contribution.

As the size of the class increases the number of different demands or needs of members also increase. It is unlikely that the ability of the instructor and class to meet different student expectations increases proportionately, since class time is not expandable. As Stephan and Mishler[15] have shown, larger groups are more likely to be dominated by the leader, and the teacher can give less individual personal attention to each group member. The research of McKeachie *et al.*[16] indicates that men high in *need* affiliation achieve well for teachers who take a personal interest in students; it might then be expected that such students would do better in small classes than in larger classes.

In order to apply these general propositions to teaching we need to ask the following questions.

In what teaching situations is the amount of information in the group important? One might, for example, hypothesize that in most courses in which knowledge is the primary goal, the relevant information is contained in books and the instructor's mind, and the amount added by students is likely to be inconsequential. On the other hand, if application is an important goal, varied knowledge of application situations contributed by students may well be significant; thus, if Thomas and Fink's principles are valid, there may be groups too small, as well as too large, to be maximally effective.

What is the effect of class size upon motivation for learning? Are there motives sufficiently common in our culture to permit the instructor to ignore idiosyncratic needs of particular group members? If the common motives for learning are not strong enough, the instructor may help students develop motives for learning. Or the instructor in a large class may consciously plan his classroom activities and assignments to prompt a wide variety of motives for learning.

What kinds of students benefit most from small sections? Both Ward[17] and Macomber and Siegel report results suggesting that the ablest students are most favorably affected by being taught in small classes. Siegel and Siegel[19] report that personal contact with the instructor was particularly important for acquisition of concepts by three types of students: (1) those with low motivation, (2) those unsophisticated in the subject matter area, and (3) those predisposed to learn facts rather than to apply or synthesize.

Is class size important for other types of students? Unfortunately, there has been little research on such problems. Class size research, which seemed to have reached a standstill, thus offers many interesting and important challenges to future researchers.

Class Size and Teaching Methods

In most courses there are several levels of goals--knowledge, critical thinking, attitudes toward learning, etc. The teacher's task is to find methods that will achieve an optimal balance of all of these. If different methods are effective for different objectives, the teacher needs to be able to use an optimal combination of these methods. Unfortunately, most teaching research has studied the effect of one method vs. another when both are repeated day after day for a semester; thus, we have little data on the relative effectiveness of differing combinations or degrees of flexibility in teaching methods.[18]

Table 1

Class Size

Reference	Course		Criteria	
		Factual Exam	Higher Level Retention & Thinking	Attitude, Motivation
Nachman & Opochinsky	Psych.	S*		
Mueller	Psych.	S		
Elliott	Psych.			S
Feldhusen	Educ. Psych.			S
Casey & Weaver	Hum. Devel.			S*
Macomber & Siegel	Psych., Marketing		S*	S*
Siegel, Adams, Macomber	Psych., Marketing		S (8 out of 9)	
Hudelson	Psych., Physics, Account., Law, Educ.	L (46 exp.) S (13 exp.) *L (6 exp.) *S (2 exp.)		
Edmondson & Mulder	Educ.	L	S	
Cheydleur	French	S (1240 classes)		

L = Large class superior
S = Small class superior
* = Difference significant at .05 level or better. All other results are the actual direction of the difference in the experiment.

While many teaching methods could be used in large groups, it is probable that more time is devoted to lecturing than in smaller classes. The large class often reduces the teacher's sense of freedom in choosing teaching methods, assigning papers, or testing to achieve varying objectives. Assuming that teachers have some repertoire of relevant skills, anything which handcuffs instructors is likely to be educationally damaging, and this may be the major way in which large classes are likely to sabotage education.

Class Size: Conclusions

It is commonplace to suggest that the effect of class size depends upon the method used, and it is probably true that the size of the group is less critical for success of lecture, for example, than for that of discussion. Moreover, class size interacts with student characteristics; i.e., small classes are educationally more important for some students than for others. But most important, our analysis of research suggests that the importance of size depends upon educational goals. In general, large classes are simply not as effective as small classes for retention of knowledge, critical thinking, and attitude change.

IV. THE LECTURE

Just as we need to look beyond the labels "large class" or "small class" to the teaching methods being used, so too we need to look beyond the labels "lecture," "discussion," "laboratory," etc., to the actual procedures. Each of these labels includes a wide variety of teaching procedures--good and bad. While the labels provide a general notion of the procedures likely to differentiate one method from another, it should be kept in mind that not every lecture or discussion fits our stereotypes: often the real determinant of what the student learns is not the apparent method but the sort of tests that are constructed and the ways in which the student expects to be evaluated for a grade.

Research on the lecture method is almost as hoary with age as that on class size. In 1925 Bane[20] published "The Lecture versus the Small Discussion Method of Teaching." In five experiments he found little difference between the methods on measures of immediate recall, but on tests given one to six months later differences favored the discussion method. Ruja,[21] however, found that the lecture was superior to discussion as measured by a test of subject matter mastery in a general psychology course. In the other two courses in his experiment there were no significant differences in this achievement, nor did any of the courses reveal differences in changes in adjustment. Similarly, Solomon, Rosenberg, and Berdek[22] found that among 24 teachers of evening college courses in American Government those who stressed lectures tended to produce higher achievement on a factual test but not on a test of comprehension. Most studies, however, have found little superiority of lecture over other methods on end-of-course achievement of factual knowledge.[23]

When we turn to measures of more complex outcomes, the results favor discussion. Hirschman[24] compared the effectiveness of presenting material by dictation with that of presenting written materials followed by discussion and rereading. The reading-discussion method resulted in the students' superior ability to identify examples of the concepts presented. Barnard[25] compared the effectiveness of a lecture-demonstration teaching method with that of a problem-solving developmental discussion in a college science course. The lecture-demonstration method proved superior on a test of specific information, but the discussion method proved to be more effective on measures of problem solving and scientific attitude. Likewise, Dawson[26] found problem-solving recitation and lecture-demonstration methods to be equally effective in a course in elementary soil science as measured by a test of recall of specific information, but the problem-solving method was significantly superior as measured by tests of problem-solving abilities.

Other evidence favoring discussion emerged from the experiment of Elliott[27] who found that students in his discussion groups in elementary psychology became interested in electing more additional courses in psychology than did students in a large lecture. Similarly, in an education course Casey and Weaver[28] found no differences in knowledge of content but superiority in attitudinal outcomes (as measured by the Minnesota Teacher Attitude Inventory) for small-group discussion as compared with lectures.

The Role of Lectures

Lecturing continues to be the most commonly used method of teaching in colleges and universities. Although it has been severely criticized, it still should not be rejected, for research has not yet dealt specifically with the strongest aspects of lecturing. For example, although one should ordinarily assign reading rather than lecture when the material is available in print,[29] books or printed materials are not always readily available in a form appropriate for a particular class. The lecturer may be able to choose from a book those elements most needed by his class, and thus he may be able to save time for students by a concise presentation of material which would require much reacing. (Even in this case,

Table 2

Lecture vs. Discussion

Reference	Course	Criteria Factual Exam	Higher Level Cognitive	Attitude, Motivation
Spence	Educ. Psych.	L*		
Remmers	Elem. Psych.	L		
Husband	Gen. Psych.	L		
Lifson *et al.*		L = D		D*
Leton	Child Devel.	L = D		
Ruja	Gen. Psych. Philos.	L* (4 classes) D (2 classes)		
Elliott	Elem. Psych.			D
Casey & Weaver	Hum. Devel. & Behavior			D
Hill	Anthro. (15 classes)	D		D
Bane	Educ. (5 experiments)	L (3) D (2)	D*(5)	
Solomon *et al.*	Govt.	L	D	
Barnard	Science (6 classes)	L	D	D*
Dawson	Elem. Soil Sci. (6 classes)	L	D	
Lancaster *et al.*	Physics	D		
Warren	Physics	D		

L = Lecture superior

D = Discussion superior

* = Difference significant at .05 level or better. All other results indicate the actual direction of difference in the experiment.

however, he might often find a dittoed handout an economical and effective alternative.)

Further, a lecturer can be an effective guide to reading. By indicating the most important points, by posing questions with which students can approach their reading, by his own appreciation and interpretation of what has been assigned, the instructor can help the student develop the ability to read in the field. Presumably this role of the instructor is particularly important at an early point in a student's entrance into a field. As the student gains experience the lecturer can rely more and more upon the student to get needed information from reading, and he can reduce the proportion of time devoted to lecturing. Unfortunately, in most courses the size of class and characteristics of the classroom prevent such flexibility from being realized.

As reading materials carry an increasing portion of the task of communicating knowledge, the lecturer's role becomes that of presenting new materials that are not yet in print. The lecture is the newspaper or journal of teaching; more than any other form of teaching it must be up-to-date.

Distribution of Lecture and Discussion Time

Many universities and large colleges use a method of distributing class meetings between lectures and discussions. This administrative arrangement is supported by research. In an experiment in which discussion meetings were substituted for one-third of the lectures[30] in psychology there were no significant differences in achievement between groups; but a follow-up study two years later showed that the partial discussion method resulted in more favorable student attitudes. Eash and Bennett[31] found that achievement was higher in psychology classes taught in three lectures (200 students) plus one 15-student discussion period per week than in classes taught four times a week in lecture-discussion classes of 30 to 50 students. Supporting this view, Lancaster *et al.*[32] and Warren[33] found that the more course time in physics devoted to recitations in proportion to lectures, the better the student achievement. On the other hand, in Remmers' comparison[34] of two lectures and one recitation vs. three recitations in psychology the *poorer* students tended to do better in the lecture-recitation combination.

The conclusion to be drawn from these studies seems to be that a combination of large lecture and small discussion sections is preferable to the common arrangement of several sections of unwieldy medium size.

Methods of Lecturing

In organizing a lecture the professor frequently is guided by the maxim--"tell them what you're going to tell them. Tell them. Then tell them what you've told them." The principle of discovery is not as new as its current "in"-ness would suggest, but it does have relevance to the problem of lecture organization.

In a classroom experiment in a course in physics[35] the instructor started with a statement of a principle and then illustrated and applied the principle. He compared this approach with a technique in which he developed principles by demonstration and analysis of application situations before the principle was stated. For students with poor backgrounds the results showed the latter (inductive) method to be superior to the former on tests of ability to apply the principles. The classic studies of college student learning by Katona[36] also support the importance of organization in learning and retention, and point toward the importance of the learner's own organization. Learning by organization, Katona found, results both in superior retention and in superior application when compared to learning by rote memorization. Therefore, the instructors' methods of organization, important as they may be, are not the sole critical element in structuring a lecture; the students' inner organization of the material received is of equal importance.

The effect of organization may well depend upon one's goal. Numerous laboratory studies point to the importance of organization for learning and memory. But these studies have not assessed the effect of organization upon motivation. The studies of National Merit Scholars by Thistlethwaite[37] lead to the conclusion that organization may be detrimental to development of an interest in a field of study. The scholars described the classes which influenced their choice of major field as ones where they did not know what to expect next. One imagines that these courses were motivating because the students experienced curiosity, surprise, and the fun of organizing complexity themselves.

One might guess that the optimal degree of disorganization and complexity is that which the student can organize for himself in his own way. Disorganization so great that students are unable to find a structure will be ineffective, as will be organization so tidy that the student can do nothing but accept it passively.[38]

While research in this area has been scanty, both the research and contemporary theories of learning and motivation suggest that a style of lecturing which poses problems and actively involves students in their solution is likely to be more effective than one presenting the principles and facts in a neatly tied package.

One of the principles of learning is that active learning is more effective than passive learning, and Bloom[39] found that students in discussion classes tend to spend more time in active thought than students in lecture classes. But this does not mean that lecture must involve passive listening and note-taking. An effective lecturer can stimulate much active thought. With the increasing use of large classes in higher education, more research is needed on different variants of the lecture method.

What is the role of the lecturer in higher education? The research results we have cited provide insufficient basis for an answer. Nevertheless, they do not contradict and sometimes support the notion that the lecture is a useful way of communicating information, particularly in classes where the use of printed materials is impractical. A good deal of evidence, however, suggests that discussion is more effective than lecturing in achieving the more complex cognitive and attitudinal objectives.

V. DISCUSSION METHODS

The chief alternative to lecture is discussion. The following theoretical concepts are relevant to the relative effectiveness of various types of discussion methods with respect to one another and to other teaching methods.

1. Active vs. Passive Learning

As we have seen, lectures place the learner in a passive role, and passive learning is generally less efficient than active learning. We would expect discussions to promote more active learning.

2. Practice and Feedback

If students are to achieve application, critical thinking, or some higher cognitive outcomes, it seems reasonable to assume that they should have an opportunity to practice application and critical thinking and to receive feedback on the results. Group discussion provides such an opportunity. While teaching machines and mock-ups may also be programmed to provide prompt and realistic feedback, the prompt feedback provided by the teaching machine may actually be less effective than a method in which students are encouraged to discover solutions for themselves with less step-by-step guidance.[40] Since problem solving ordinarily requires information, discussion might be expected to be more effective for groups with larger amounts of information than for those lacking in background. Some support for this hypothesis is provided by a study of the learning of children in visiting a museum. Melton, Feldman, and Mason[41] found that lectures were more effective than discussions for children in grades five, six, and seven, but discussions were more effective for eighth graders. Unfortunately, no one has carried out studies on the relative effectiveness of discussion at different points in a course or curriculum. One might expect that discussion techniques would sometimes be effective in generating questions and reducing resistance to learning a new topic, but that lecture and reading might then precede developmental or problem-solving discussions of the topic.

3. Motivation

A decade or two ago psychologists discussing motivation would have talked about reward and punishment and suggested that teachers look at the rewards for learning in the classroom. Rewards and punishments do play an important role in determining what we learn. But the revolution in motivation research and theory lies in new evidence that man is naturally curious. He seeks new experiences; he enjoys learning new things; he finds satisfaction in solving a puzzle or developing a skill.

How does this generalization apply to learning in college? It is tempting to answer this question in vague phrases, such as "varied teaching methods," "posing new, but soluble problems," or "setting realistic standards of achievement." But we can go further. One hint comes from studies by Berlyne.[42] He found that asking questions of students, rather than presenting statements of fact, not only improved learning but also increased interest in further learning about the topic. Questions, he found, were particularly effective in arousing curiosity about things which were already familiar, and the most successful questions were those that were most unexpected. The interplay between familiar and novel may thus be a very significant factor in the development of curiosity. Hence, the unsettling lack of certainty about "where we're going" may actually be one of the assets of the discussion method.[43]

4. Group Variables

A final theoretical input to consideration of discussion methods derives from social and clinical psychological studies of attitudinal and personality change. Failure to achieve some goals of learning may be due to emotional barriers in the learner rather than to his lack of intelligence or to deficiencies in the materials presented. For example, a psychology student may learn that distributed practice is effective, but he still may not change his study methods because his anxiety about grades is so great that he does not dare try anything different; a student of literature may fail to see the essential elements of a novel because it comes too close to his own problems; a mathematics student may have a "block" against mathematics; a history student may resist materials counter to his concept of American idealism; a potentially creative student may inhibit his intuitions because of insecurity.

Social and clinical psychological theory suggests that expressing one's attitude in a nonthreatening situation may help "unfreeze" the attitude. A permissive group discussion may provide such opportunities for expression as well as give opportunities for group members to express other attitudes which may be instrumental in meeting the individual's needs.

Most attitudes influencing learning have some interpersonal antecedents and are stabilized by one's perception of the attitudes of other liked persons. Group discussion may facilitate a high degree of liking for the instructor and for other group members. It also permits more accurate assessment of group norms than is likely to occur with other techniques of instruction. Consequently, the social influence of the group may facilitate change. In fact, while individual instruction would be advantageous for many teaching purposes, group processes can provide a real advantage in bringing about changes in motivation and attitudes. In his classic experiments on group decision, Lewin[44] showed that it is sometimes easier for a group than for an individual to change.

Whether or not discussions actually achieve these theoretical values is another question, for discussions range from monologues in which occasional questions are interposed to bull sessions in which the instructor is an interested (or bored) observer. Nevertheless, a good deal of research has attempted to compare the effectiveness of various discussion techniques.

5. Student-Centered vs. Instructor-Centered Discussion

A wide variety of discussion methods are described by the adjectives "student-centered," "non-directive," "group-centered," or"democratic." They have in common the desire to break away from the traditional instructor-dominated classroom and to encourage greater student participation and responsibility.

From the standpoint of learning theory, student-centered teaching in its more extreme forms might be expected to have some serious weaknesses, at least in achieving lower-level cognitive goals. With the instructor's role as information giver reduced, his role as source of feedback virtually eliminated, and his opportunity to provide organization and structure curtailed, it is apparent that a heavy burden falls upon the group member to carry out

Table 3

Dimensions Upon Which Student-Centered and Instructor-Centered Methods May Differ

Student-Centered	Instructor-Centered
Goals	
Determined by Group (Faw, 1949)	Determined by instructor
Emphasis upon affective and attitudinal changes (Faw, 1949)	Emphasis upon intellectual changes
Attempts to develop group cohesiveness (Bovard, 1951)	No attempt to develop group cohesiveness
Classroom Activities	
Much student participation (Faw, 1949)	Much instructor participation
Student-student interaction (McKeachie, 1951)	Instructor-student interaction
Instructor accepts erroneous or irrelevant student contributions (Faw, 1949)	Instructor corrects, criticizes, or rejects erroneous or irrelevant student contributions
Group decides upon own activities (McKeachie, 1951)	Instructor determines activities
Discussion of students' personal experiences encouraged (Faw, 1949)	Discussion kept on course materials
De-emphasis of tests and grades (Asch, 1951)	Traditional use of tests and grades
Students share responsibility for evaluation (Ashmus and Haigh, 1952)	
Instructor interprets feelings and ideas of class member when it is necessary for class progress (Axelrod, 1955)	Instructor avoids interpretation of feelings
Reaction reports (Asch, 1951)	No reaction reports

This table was taken from W. J. McKeachie and G. Kimble. Teaching Tips: A Guide-Book for the Beginning College Teacher. 5th edition. Ann Arbor, Wahr, 1965.

any of these functions that are necessary. Since student-centered teaching attempts to reduce dependence upon the instructor, it would also be expected to diminish his influence as a prestige figure. However, this may be more than compensated for by increased freedom of expression and increased potency of group norms as sources of influence. An interesting unanswered research question is the effect of the change in the instructor's role upon students' tendencies to use him as a model.

I have reviewed the research on student-centered teaching in detail in another article[45] where the results tend to support the theory just put forward. Although we might expect student-centered teaching to be ineffective in achieving lower-order cognitive objectives, there seem to be few instances of such a loss. Students apparently can get information from textbooks as well as from the instructor. The prediction that any superiority of student-centered discussion methods should be revealed in higher-level outcomes was confirmed. In 11 studies significant differences in ability to apply concepts, in attitudes, in motivation, or in group membership skills have been found between discussion techniques emphasizing freer student participation and those with greater instructor dominance. In 10 of these studies the differences favored the more student-centered method; the eleventh[46] had mixed results.

Other evidence supports the value of some degree of studentcenteredness in teaching methods. Thistlethwaite[47] found that National Merit Scholars in assessing characteristics of teachers who contributed most to their desire to learn checked "allowing time for classroom discussion," as one of the outstanding characteristics. Other characteristics mentioned included "modifying course content to meet students' needs and interests," "treating students as colleagues," and "taking a personal interest in students." However, in line with our earlier discussion of feedback, another trait mentioned was "providing evaluations reassuring the student of his creative or productive potentialities." Similarly, Solomon, Rosenberg, and Berdek[48] found a nonlinear relationship between scores on a test of comprehension and permissiveness. Moderate permissiveness was most effective.

A recently completed and as yet unpublished study by a University of Michigan research group also has shown that psychology instructors whose students do best on achievement tests of critical thinking (with intelligence controlled) tend to be described as follows: "He listened attentively to what class members had to say." "He was friendly." "He was permissive and flexible." "He explained the reasons for criticism." "Things are explained clearly." "He is skillful in observing student reactions." Both the Thistlethwaite and Michigan results, then, support the value of student-centered teaching for motivation and critical thinking.

The choice of instructor-centered vs. student-centered discussion thus appears to depend upon one's goals. The more highly one values outcomes going beyond knowledge acquisition, the more likely it is that methods involving a considerable amount of student group participation and responsibility will be preferred.

6. Instructorless Student Discussion Groups

One of the newer developments in discussion techniques is student-led discussions. As Leuba[49] of Antioch College has said:

> A student is likely to understand a concept, principle, or other idea only as he questions himself about it, looks for its implications and applications, puts it into his own words, and integrates it with previously acquired knowledge.... Unless he reflects at length on the implications and applications of what he is reading, the ideas in a book will occur to him only in connection with the limited situations mentioned in the reading itself....
>
> A well-motivated, experienced student can do by himself much of what is implied in a self-recitation-reflection method of study. And he himself can supply at least some discriminating commendations and criticisms for his ideas; he can be his own judge. But before he is adequately motivated and experienced, he may be very dependent upon the stimulation, guidance, and feedback provided by interaction with his peers and with the instructor: hence, the importance of small group independent study and of guidance from the instructor, both in learning how to learn effectively and in interacting successfully with others to promote learning.

This innovation has often been related to attempts to develop an independent study program.

Probably the use of this technique most suited to "1984" is found in colleges where a number of meeting rooms are linked to a central monitoring room so that the instructor can listen in and interpose comments in any of several student-led discussions. Leuba reports satisfying results with this technique in psychology courses, and Webb and Grib[50] report the superiority of this technique in achievement in statistics and philosophy courses. The earlier research at Antioch[51] found no consistent differences in effectiveness between small, student-led groups and conventional instructor-led lecture-discussion.

In experiments in educational psychology and general psychology, Gruber and Weitman[52] found that students taught in small discussion groups without a teacher did at least as well on a final examination as students who heard the teacher lecture and were also superior in curiosity (as measured by question-asking behavior) and in interest in educational psychology. The discussion students reported a larger number of readings during the term, while the lecture students reported more attempts to apply their learning. In one experiment in physical optics the students in lecture were superior to student-led discussion students on a test of facts and simple problems but inferior on complex problems and learning new material. The superiority of student-led discussions was particularly marked for students below the median in ability. In Beach's[53] study, students high in sociability achieved significantly more on a factual test than less sociable students in small, student-led discussions, and conversely, less sociable students achieved more than sociable students in a lecture session.

Student-led discussions thus appear to offer a useful technique of providing the values of small-group discussion not only when staff resources are too limited to permit teacher-led groups, but even when regular teachers are available. It has already been seen that permissiveness is a teacher characteristic that contributes to effectiveness; Webb and Grib[54] note that students report as a major advantage of the student-led discussions their feeling of freedom to ask questions and express their own opinions. It makes theoretical sense that this opportunity to expose one's own ignorance and vent one's feelings should contribute to learning.

Probably the most convincing demonstration of the effectiveness of student-led discussions is the "Pyramid Project" carried out at Pennsylvania State University.[55] In this project a faculty member, graduate students, and seniors planned the activities for the program. The seniors assisted by juniors led small-group discussions. In courses in sociology and psychology, these small discussion sections, led by more advanced undergraduate students, supplemented the regular course activities. As compared with supplementary instructor-led lectures, film presentations and demonstrations, or no supplement, the small groups led by juniors and seniors read more, were more likely to go on to major in the subject, had more favorable attitudes toward the role of sociologists (or psychologists), and (in psychology) accepted more responsibility for their own learning, showed a more intellectual (less vocational) attitude toward college, and performed better on tests of scientific thinking, persistence in critical thinking, and resourcefulness in problem solving. Equally important was the favorable effect of the experience upon the junior and senior group leaders.

The "Free University" movement is perhaps another descendant of student-centered methods. Free University courses, organized outside the formal curriculum with a large degree of student initiative, have attracted a good deal of publicity, but so far there appears to be no attempt to analyze their effectiveness.

Lecture vs. Discussion: Conclusions

Since discussion offers the opportunity for a good deal of student activity and feedback, it should be (according to theory) and is (according to research results) more effective than typical lectures in developing concepts and problem-solving skills. However, because the rate of transmission of information is slow in discussion classes, it could be expected that lecture classes, reading, and other more rapid means of transmitting information would be superior to discussions in attaining the objective of teaching knowledge. Research results also tend to support this generalization, although the probable reason such results are not more convincing is largely because the knowledge tested on course examinations usually can be learned by reading the textbook. Finally, the research results indicate a superiority of discussion over lecture in affecting motivation and attitudes.

VI. EXPERIENTIAL LEARNING

The student-centered teaching movement has been concerned not only with student learning in the traditional sense but has brought to the fore a set of objectives that previously had been peripheral to higher education. Essentially, advocates of student-centered teaching suggested that knowledge was less important as an end in itself than as a basis for problem solving and further learning. Thus, it was important that students not only accumulate knowledge but learn how to use it. Advocates of student-centered instruction also placed a high value on motivational and attitudinal outcomes of education. Carl Rogers, one of the godfathers of the movement, expressed it thus:

> This would seem to mean that the goal of democratic education is to assist students to become individuals
>
> who are able to take self-initiated action and to be responsible for those actions;
> who are capable of intelligent choice and self-direction;
> who are critical learners, able to evaluate the contributions made by others;
> who have acquired knowledge relevant to the solution of problems;
> who, even more importantly, are able to adapt flexibly and intelligently to new problem situations;
> who have internalized an adaptive mode of approach to problems, utilizing all pertinent experience freely and creatively;

> who are able to cooperate effectively with others in
> these various activities;
> who work, not for the approval of others, but in terms
> of their own socialized purposes.

The modern counterparts of this crusade for democracy are probably a group of innovators who stress the role of personal experience in education. One representation of this is the "T-Group,"[57] developed by Benne, Bradford, Lippitt, and others[58] as a technique of training for group leadership and membership. T-Group methods have been used in courses at Harvard, Michigan, Boston University, and other institutions. In graduate and professional courses, the T-Group is used to develop interpersonal and group skills. At the undergraduate level the T-Group is more frequently used in connection with a social-science course in which assignments are given and discussion of the content varies between the assignment and the group's own processes.

Although evaluation of T-Group methods for training management personnel indicate that some lasting changes occur in participants, there are few reports of its success as a method of achieving educational objectives in college. Menlo[59] reports use of a variety of group, subgroup, and laboratory methods in a course in adult education. Attitudinal measures indicated changes from the beginning to the end of the course toward such goals as more positive perceptions of self and greater readiness to share leadership. It would be useful to have studies comparing such techniques with more conventional methods, not only with respect to these goals, but with respect to more usual cognitive goals.

Another approach to experiential learning is represented by attempts to relate to higher education: volunteer service in mental hospitals, tutorial work with culturally deprived children, and other direct work experience. One theoretical basis for such approaches is the thesis that real-life problems create strong motivations for learning. Problems generated by experiences in non-classroom settings can thus facilitate the development of observational, conceptual, and behavioral skills, with theoretical abstractions given concrete meaning. A second rationale is that if one's goal in higher education is to develop "learners," one must give students practice in learning from their own experience as well as from books. "Project Outreach," a program conceived and carried out by the staff of the introductory psychology course at the University of Michigan, is highly motivating for the graduate teaching fellows and the undergraduate students involved, but so far no objective measures have been made of student learning in relation to conventional methods.

Social activism plus the shift in the needs of society from production workers to service workers make attempts to relate intellectual and service activities an important educational frontier. The effect of such experience on motivation and on intellectual outcomes is an important research gap.

VII. READING, PROGRAMMED LEARNING, AND INDEPENDENT STUDY

Reading

In some universities a quiet revolution in teaching has occurred over the past few years. This is the revolution in the use of printed materials, such as paperback books, offprints of journal articles, facsimile or microfilm copies, and other duplicated materials. As a result of this change in techniques of presenting, reproducing, marketing, and circulating printed materials, not only is the student now able to own a richer variety of resources, but the new open-stack libraries invite him to go beyond his assignments to books and journals giving other viewpoints and additional information.

In discussions of the remarkable values of bringing "Master Teachers" to all learners through television, the fact is often overlooked that through books and printed materials the student not only can follow the teaching of a master teacher but can actually choose from a number of master teachers the one who best communicates with him. In fact, in the cacophony of claims for newer methods of instruction with greater individualization and better use of scare teaching manpower, the claims of reading have been slighted. If we look at individualization, for example, we find that the reader controls his own pace--reviewing or moving ahead as he wishes. With the great availability of books and articles, he also has a much greater choice in the level of difficulty and interest than in other media. Moreover, the speed of printed communication of information is faster than for other teaching media.

An early study[60] found that students learned as well from reading material themselves as from listening to the same material read aloud. The better students, moreover, profited more from reading than from listening. A number of other studies have compared printed materials with lectures, and the results--at least with difficult materials--favor print.[61] However, the amount of research on books or articles as media for teaching is remarkably small considering their widespread use. There have been studies of size of print, readability, and the effectiveness of illustrations (illustrations apparently do not contribute much to learning as measured by conventional tests), but there is more that needs to be done.

The greatest deficiency is in research on effective methods of using printed materials. Hiler and McKeachie[62] demonstrated that students read more efficiently when they are given questions to answer on the material. The classic study of Gates[63] also illustrates the value of active questioning and recitation vs. passive reading. Kaplan[64] describes the use of reading logs in programs where students are expected to spend a major part of their study time reading books and articles of their own choice. He reports (and my own experience confirms) that students not only read a great deal but that their logs show marked improvement in critical and integrative ability. The key to this improvement probably lies in the extensive teacher comments upon the logs, which are periodically turned in to the instructor. Kaplan reports favorable student reactions, but little research has been reported comparing different techniques of utilizing such printed materials.

Programmed Instruction

One of the newer developments in textbook construction is the "programmed textbook," an instructional book developed by utilizing the learning-in-small-steps sequence of the conventional teaching machine. Such books and booklets are sometimes designed as adjuncts to normal teaching materials and are sometimes intended to replace textbooks.

The teaching machine is a device for presenting questions in predetermined sequences and providing immediate knowledge of results to an active learner. Teaching machines do not ordinarily permit the learner to proceed at his own rate, since he ordinarily responds by writing an answer or pressing a button before additional information or the next question is presented. This means that progress is generally slower than with conventional books. Nevertheless, the learner has more control over the pace of learning than he does with television or most large lectures. With this method the successive questions proceed in small steps from the simple to the complex. With some machines, the student may, if he makes a series of correct responses, adjust the machine to skip some steps; if he fails items, they are repeated. The program of the lesson may include hints or other guidance.

There have been two general types of approach to the use of teaching machines. In the early investigations of Pressey and his students the teaching machine was used primarily as a device to provide prompt knowledge of results of conventional testing procedures. The testing machine was thus simply a supplement to the conventional teaching methods. The second approach, originated by Skinner and his followers, uses the teaching machine as a substitute for other teaching methods; the teaching machine is used either as the sole instrument of instruction or at least as a major method which may be supplemented by the teacher. In some cases the "program" (the series of questions or statements presented to the student) is presented in text or workbook, and "programmed instruction" is now used to refer to any carefully sequenced presentation whether by teaching machine, book, lecture, film, or television.

Some research evidence supports the use of teaching-testing machines as supplements to conventional instruction. Angell,[65] Peterson and Peterson,[66] and Stephens[67] found that immediate knowledge of results on a quiz or special answer sheet produced results superior to those obtained when such knowledge was delayed until the next class meeting.

The research with Skinnerian types of programs has been less encouraging. Students do learn from the programs, but learning is generally slower than with conventional printed materials (but faster than lectures).[68] In some cases, achievement is higher for the programmed learners,[69] and one must judge whether the extra investment in time is justified by the gain in learning. In other cases, programs produce less learning than conventional sources.[70]

The controversy over whether a student needs to make a response has largely abated. If the response itself must be learned, as in teaching typewriting or a new vocabulary, an overt response is required, but in most college courses the responses required are already in the student's repertoire and he learns more rapidly by not stopping to fill in blanks.[71]

One would expect the strict control over the structure and pace of learning to be most helpful to students with poor study habits, those who read passively and tend to slide over important uncomprehended points, but little research has been done to determine what kinds of students gain from programs or what types of objectives can be most efficiently achieved. On the basis of the theoretical relationship between uncertainty and curiosity, it might be expected that most students would be bored by the practice of writing programs so that every question is answered correctly by almost every student. On the basis of Atkinson's theory it would be expected that students with a high need for achievement (those who work hardest in situations with 50-50 probabilities of success) would find the usual small-step program more boring than would other students. And this is what Moore, Smith, and Teevan[72] discovered. But even for students in general, the University of Illinois project suggests that logical sequences of items may be less efficient for learning than a random sequence.[73] A less expected but reasonable finding is that students scoring high on a sociability test would do poorly with programmed instructions.[74] Carroll[75] has demonstrated in two language programs that aptitude is related to rate of learning of a program, and Lublin[76] reports that students low in need for autonomy achieved more in a programmed course than students high in this need. As more complex integrations of programs, computers, discussion groups, and teachers are developed, the dimension of student autonomy and desire for control of his own learning is likely to be important.

The popular furor over teaching machines and programmed learning is now subsiding, and research is beginning to clarify their uses.[77] Present programs are not panaceas for the problems of American higher education. For a while it appeared that programmed materials might enable educators to shortcut the difficult problems of curriculum and course organization, but programs that teach unimportant concepts or information that is untrue are not of much help to education, and it is now recognized that the writing of a good program requires as much scholarship as the writing of a good textbook.[78] Unfortunately, programming is hard work and as yet scholars seem less willing to write programs than to write books, so that we still have a very limited number of good programs for college use. In fact, college-level programs adapted to computer-assisted instruction are almost nonexistent.

Programmed instruction has also suffered from a lack of evaluation skills. To many of its advocates, it has seemed self-evident that anyone who completes a program successfully has learned--he has achieved the goals of the program. Professors like to make the same assumption about their lectures. But most teachers have had the disheartening experience of discovering that points made crystal clear in a brilliant lecture seem not to have penetrated the awareness of students sufficiently enough to be recalled and used in responding to a relevant examination question. One of the problems for programmers of college materials is that in college teaching the level of conceptualization is such that the student's required response to a program question is only one of a class of related responses to a group of stimuli. The fact that the student makes the appropriate program response is not prima facie evidence that he has learned the concept or class of responses. Sometimes the programmer provides irrelevant cues to which the student learns to make the desired response; at other times the response required in the program is irrelevant to the goal of teaching; i.e., the response may simply indicate that the student has read the frame, as when he is asked to fill in a trivial word.

Some program writers have recognized the importance of a test of learning apart from the program, but such tests frequently contain items from the program or simple paraphrases of these items. Correct answers to such items are not very reassuring to the skeptic, since it is possible that a high score can be obtained by someone who has learned to respond to irrelevant cues or has learned only the specific responses taught in the program rather than the principle or concept desired. Ideally, the test should measure achievement of the goals of the program in a manner as different as possible from the program items.

The programmed learning movement has had the healthy effect of forcing clarification of educational objectives. But after asking for a list of objectives precise enough to serve as guides for programming, the programmed learning protagonists tend to dismiss as unreal any objectives which cannot be specified at a level appropriate for programming. The result is that programs are often aimed at the most trivial objectives. Disillusionment with the programmed learning movement springs in part from the fact that once a program had been written,educators too often discovered that what it taught was not really what their students needed to learn.

Despite these problems, programmed learning is here to stay and can make a real contribution to higher education. Few teachers enjoy the role of drillmaster; yet drill has seemed necessary if students were to thoroughly master certain necessary facts, schemata, or responses. This, at least, is a task programs can perform, freeing the instructor for other functions. And more is also possible. Computers can individualize instruction as printed programs do not. Early attempts to use computers in instruction simply put conventional linear and branching programs into the computer so that the capacity of the computer was not really used to increase the complexity of the teaching. Feurzeig, Swets, and others[79] at Bolt, Beranek, and Newman, Inc., have been using computerized techniques to develop analytical thinking, such as that used in medical diagnosis. A similar program for simulating a laboratory in qualitative analysis has been described by Hirsch and Moncrieff.[80] In these systems, students can ask questions as well as answer those posed by the computer. The student can also volunteer assertions or solutions whenever he wishes. The computer responds in a meaningful way both to student questions and assertions. It recognizes inappropriate responses. It remembers previous responses. The anthropomorphic terms "recognizes" and "remembers" are not really inaccurate, for they describe the phenomenal experience of the student interacting with the computer. While it might be more objective to say that the program is written in terms of strings of conditional "if-then" probabilities, much of the motivational value of the computer lies in the student's attempt to test its humanlike qualities.

Two experiments in computer-assisted college level instruction[81] have been reported, and both showed savings in time and improved performance compared to conventional instruction and programmed text. Moreover, students enjoyed studies with the computer. With computer programs of this sort the motivational value of unexpectedness can be retained, and programs can be adopted for students of differing types. Frase[82] has experimented with the effects of varying praise and reproof upon programmed-learning students differing in aggression, deference, and other personality characteristics.

Computerized instruction will demand the development of complex teaching strategies. One of these may be the Socratic dialogue, which was the rallying cry of teaching machine salesmen. But we have not yet tapped the full potential of programming, for in its broadest sense programming is simply careful, systematic, educational planning. Probably the greatest contribution of the programmed instruction movement has been its pressure on teachers to think through their objectives. As programming escapes its bondage to teaching machines, the programmed learning movement may help swell the more general trend toward systematically relating means and ends of education.[83]

Independent Study

One of the advantages of programmed materials is that they can be used with relatively little teacher supervision. They force the student to read carefully and actively. Thus, the programmed learning movement has looked for allies among the proponents of independent study. If one goal of education is to help the student develop the ability to continue learning after his formal education is complete, it seems reasonable that he should have undergone supervised experience in learning independently--experience in which the instructor helps the student learn how to formulate problems, find answers, and evaluate his progress himself.

Independent study has a strong kinship with the project method which became popular a generation ago. One of the first "independent study" experiments was that of Seashore.[84] His course consisted primarily of guided individual study with written reports on eight projects, each of which took about a month to complete. Final examination scores, however, were no different for these students than for students taught by the usual lecture-discussion method.[85] In a study in a college botany course, Novak[86] found that students in conventional classes learned more facts than did those taught by the project method. Similarly, Goldstein[87] reports that students taught pharmacology by a project method did not learn more than those taught in a standard laboratory.

Unfortunately, measures of achievement such as those used in the studies just noted are probably not sufficient measures of the purported objectives of project instruction. Presumably the real superiority of the project method should be revealed in measures of motivation and resourcefulness. One morsel of support comes from Thistlethwaite's[88] finding that National Merit Scholars checked the requirement of a term paper or laboratory project as one characteristic of their most stimulating course, but most research on independent study has failed to find expected gains in motivation, learning, or even independence.[89] While our earlier discussion of reading indicated that students could learn effectively from reading a single lesson, one apparently cannot generalize further that students should be turned loose to read for an entire course. Whether factual learning is affected probably depends largely on the measures used and whether independent study involves reading materials other than those assigned in conventional classes.

If one sends students home with the textbook only, they do better on a test of knowledge of that text than students who have had a chance to get other ideas from a teacher or class discussion.[90] On the other hand, if students in independent study are expected to read other books as well as the text they probably will do less well on an examination on the text.[91] Even this conclusion must be conditioned by the context of our discussion. The Parsons, Ketcham, and Beach study,[90] which produced the clearest supporting evidence, included a group of teachers who were enrolled for a Saturday class at a university. This group did not achieve well under independent study conditions, presumably because their home environment was not as conducive to study as the campus. Few studies attempt to assess the unique learning of independent study or control groups from classroom lectures and discussion or from additional reading. One of the most comprehensive studies--that at Antioch in 1957-58[92]--

found no consistent differences in results between lecture-discussion, student-led groups, and individual independent study.

The most favorable results on independent study were obtained in the Colorado experiments discussed earlier.[93] In addition to the studies reported under the heading "Student-led Discussion" several experiments involved individual study or voluntary discussion. For example, in a course in Freshman English in which the group met only about 90 per cent of the regularly scheduled hours and had little formal training in grammar, the scores on a test of grammar for students under self-directed study were significantly superior to those of control groups. Beach[94] found similar results for self-directed student discussion groups at Whitworth College. As compared with classroom groups, the self-directed groups were superior in quantity and quality of study, amount of required and non-required reading, and publications consulted in writing term papers. These are the sort of results one would hope for in independent study.

The experiment reported by McKeachie, Lin, Forrin, and Teevan[95] also involved a meeting with the instructor at least biweekly. The results of the experiment suggest that the "tutorial" students did not learn as much from the textbook as students taught in conventional lecture and discussion section classes, but they did develop stronger motivation both for course work and for continued learning after the course.

As with the other methods reviewed, it is probable that independent study is particularly effective with certain types of students. Unfortunately, we have only glimmerings of knowledge about which student characteristics are important. McCullough and Van Atta[96] found that students who are less rigid and less in need of social support are likely to profit more from independent study than students scoring high in these characteristics. Koenig and McKeachie [97] found that women high in need for achievement preferred independent study to lectures, and Patton[98] similarly found that students high in need for achievement assumed responsibility and learned well in a class with a lesser amount of direction by the instructor.

These and other studies[99] lead to the conclusion that if a student knows that he is going to be tested on the factual content of a particular book, it is usually more advantageous for him to read that book than to participate in other educational activities. In fact, one might suggest that even better results could be obtained if the desired facts could be identified by giving the student test questions in advance. But knowledge of specific facts is not the typical major objective of an independent study program. What is hoped for is greater integration, increased purposefulness, and more intense motivation for further study. That independent study can achieve these ends is indicated by the Colorado, Whitworth, and Michigan experiments. But the paucity of positive results suggests that we need more research on methods of selecting and training students for independent study, arranging the independent study experience, and measuring outcomes.

VIII. LABORATORY METHODS

Theoretically, the activity of the student and the frequent individualization of laboratory instruction should contribute positively to learning. However, information cannot usually be obtained by direct laboratory or field experience as rapidly as from abstractions presented orally or by printing. Films, demonstrations, ready-made drawings, or labeled photomicrographs may also shortcut some of the trial and error of the laboratory. Thus, one would not expect laboratory teaching to have an advantage over other teaching methods in amount of information learned. Rather, one might expect the differences to be revealed in actual skill in observation, in manipulation of materials, or, because of the multisensory vividness of laboratory learning, in retention or application. Little research has attempted to test these special types of outcome. If these outcomes are unmeasured, a finding of no difference in effectiveness between laboratory and other methods of instruction is almost meaningless since there is little reason to expect laboratory teaching to be effective in simple communication of information.

In experiments in physics and engineering, Kruglak[101] and White[102] found that students taught by individual or group laboratory methods achieved more than those taught by lecture-demonstration. In studies by Balcziak,[103] Dearden,[104] and Trotter,[105] however, laboratory teaching was compared with (1) lecture-demonstration, (2) combined demonstration and laboratory, (3) workbook, and (4) term paper in physical science, general biology, and home economics courses, and no significant differences were found between methods as measured by tests of information, practical application, scientific attitude, or laboratory performance. Earlier experiments[106] found no significant loss resulting from reduction in laboratory time or assignment of one cadaver to four students rather than two.

The foregoing studies tend toward the conclusion that time spent in the laboratory could be reduced without educational loss. However, the results of research on methods of teaching in the laboratory indicate that the effectiveness of the laboratory depends on the manner in which the work is taught. Novak,[107] for example, used labeled photomicrographs as an aid in teaching a project-centered general botany course and found that they aided achievement in a botany laboratory. Bainter[108] found that a problem-solving method was superior to traditional laboratory manual methods in teaching students to apply principles of physics in interpreting phenomena. Lahti[109] also found a problem-solving method to be superior to more conventional procedures in developing students' ability to design an experiment. Because many laboratory teachers have been interested in teaching problem-solving methods, this may be an appropriate place to note Burkhardt's finding[110] that students who are taught calculus with an emphasis on the understanding of concepts learn concepts better than students taught with conventional emphasis upon the solving of problems. On the face of it this might appear to be in opposition to the results of Kruglak, Bainter, and Lahti. Actually all of these studies point to the importance of developing understanding rather than teaching solution of problems by going through a routine series of steps. Whether the laboratory is superior to the lecture-demonstration in developing understanding and problem-solving skills probably depends upon the extent to which understanding of concepts and general problem-solving procedures are emphasized as opposed to "cookbook" methods.

IX. SIMULATION

As remote terminals of computers begin to sprout throughout the campus, simulation is likely to take the place of television, independent study, and programmed instruction as the glamor method of the 1970's. "Games" or simulations are ordinarily intended to develop skills in making decisions, to give students understanding of the principal parameters of a field, and to develop motivation for learning. Simulation does not necessitate the use of a computer, but computers can assist in providing rapid calculations and prompt feedback on the results of decisions. According to theory, the active participation, uncertainty as to outcome, and prompt feedback should be motivating and effective for learning.

Presumably simulation can be used in almost any subject matter. For example, in science courses the variables and equations of a theory can be programmed onto a computer and students given the task of designing experiments to run on the computer to test their hypotheses about "nature" as represented in the computer.[111] Simulation is presently used mostly in teaching political science and business courses, although there are some games used in courses in education and other fields; we also have mentioned in the programmed learning section the computer simulations of medical diagnosis and chemistry laboratory.

Although much time and money have been spent in developing simulations, I can find only two college-level studies evaluating their effectiveness.[112] On a variety of measures, simulation was favored only modestly by results. This should not lead to the conclusion that simulation should be abandoned. As we have seen in our evaluation of other teaching methods, the gap between theory and research findings was narrowed only as one was able to view the results of a number of studies. The studies to date should dampen the uncritical enthusiasm that often accompanies innovations, but the findings contain enough glimmerings of paydirt to justify further research.

X. AUDIOVISUAL DEVICES

Most higher education is verbal and conceptual. Words are wonderfully efficient substitutes for direct sensory experiences, but on occasion visual identification, discrimination, or eye-hand responses are important goals of education. In such cases audiovisual aids may substitute for direct experience.

Television

The most widely publicized solution to the problem of teaching greater numbers of college students has been the use of closed-circuit television to enable a single teacher to reach several classrooms. Although some experiments were not well enough designed to permit evaluation of their results, there are probably more good comparisons of television and live instruction than of any other teaching methods. The results are also much more consistent than are any other comparisons. In the great majority of experiments in which there were adequate controls, greater learning occurred in "live" classes than in those taught by television.[113] Most of these differences were not statistically significant by themselves, but their consistency is statistically significant. One can thus conclude that at the college level[114] television is generally not as effective as face-to-face instruction.

The conclusion, however, is not a simple one. In the first place, goals of instruction are important. While television instruction seems to be inferior on all types of measures that have been used, there is still a hidden criterion problem which troubles most research on teaching. Television should be at its best in teaching visual recognition and form discrimination. Present tests of achievement, however, are almost entirely verbal. We do not know whether television students are better able to recognize or evaluate some visual properties because we have not usually measured this ability. Where there are courses in which visual skills are important objectives, one might expect television to be superior to conventional instruction. A second condition upon the simplicity of the conclusion that television is inefficient is the instructor. There is some evidence in both Army and college studies that certain instructors blossom before the TV cameras and actually are more effective than in their ordinary classes. There are others who freeze when the red light on the camera goes on. A third variable is the student, and a fourth is the instructional methods used. Complex interactions of these variables occur.[115]

Films

Like the advocates of television and teaching machines, edu-

Table 4

Television vs. Conventional Teaching[144]

Reference		Criteria	
	Factual Knowledge	Retention Higher Level Cognitive	Attitude Motivation Personality
Social Science			
Carpenter and Greenhill			
Psych.	C,C	C	C
Sociol.	C		
Macomber and Siegel			
Psych.	TV,C,C*,C,C,C	C	C
Sociol.	TV		
Econ.	C,C*	C*,C*,C	
LePore and Wilson			
(Psych.)	TV	TV	C
Humanities			
Carpenter and Greenhill			
(Music Apprec.)	C		
LePore and Wilson			
(English)	?		C
Klapper			
(English)	C,TV	C,C	
Seibert			
(English)	C*	C	
Natural Science and Engineering			
Carpenter and Greenhill			
Chemistry	C,TV		
Meteorology	C		
Macomber and Siegel			
Physiol.	TV,C,C	TV	
Biol.	TV*		
Zoology		C	

Table 4 (cont'd)

Reference	Criteria Factual Knowledge	 Retention Higher Level Cognitive	 Attitude Motivation Personality
Seibert			
Chem.	C	C	
Mech. Engin.	C		
Martin *et al.*			
Chem.	TV*		
Graphics	TV*		
LePore and Wilson (Science)	C,TV	TV,C	C,C
Miscellaneous			
Macomber and Siegel (Air Science)	TV,C,TV,C*, C,TV,C,C		
Seibert			
Math.	TV		
Calculus	C		
Kasten and Seibert (Military Sci.)	C		
Grossman *et al.* (Dentistry)	TV,C,C		
McDaniel and Filiatreau (Educ.)			C*

*Significant beyond the .05 level of confidence

TV = TV superior

C = Conventional class superior

Differences are simply the actual direction of results of the experiment; when more than two measures were used, the table reports the direction of the majority of the measures.

cational film experts have been frustrated by lack of acceptance by college faculties. The only difference is that for the audiovisual aid men the frustration has now subsided into a dull pain; for after some forty years of experience they no longer cherish a vision of leading a revolution that will topple existing teaching methods. Films have found a modicum of acceptance; good films are available in most fields and most professors are willing to accept their educational value (that is, when used sparingly; the professor who uses a large number of films still is assumed to be shirking his work).

Most of the research on educational films has been carried out by the Armed Forces or in elementary schools. While it is not appropriate to review this research in detail, certain emerging principles seem relevant to our purposes.[116]

1. Students can learn from films, and usually do learn at least as much as from a poor teacher.[117] 2. Such learning is not confined to details but may include concepts and attitudes.[118] 3. Outline material such as titles and commentary increase learning if a film is not well-organized.[119] 4. For less intelligent students, repetition of the film increases learning.[120] 5. Students learn how to learn from films, i.e., students with previous experience with instructional films learn more than students with-

out previous experience, at least for students with little previous knowledge of the film subject matter.[121] 6. Presenting pictures is more effective than presenting words as stimuli in rote association tasks such as learning a foreign language.[122] 7. Participation increases learning.[123] In this study, active response with prompting and feedback was most effective on the most difficult material with the least motivated, least able students--a finding which probably has wide generality in teaching.[124] However, Ash and Carlton[125] found that note-taking during a film was not effective. This suggests that active participation needs to be planned in the production of a film or television presentation rather than being interjected as an additional task for the student. Snow, Tiffin, and Seibert[126] found that active, assertive students and students low in responsibility learn less well from films than from live demonstration. It may be that such students particularly need participation devices.[127]

Language Laboratories and Tape Recorders

Tape recorders are now convenient and relatively inexpensive tools available for teaching. Their original and most common use has been in language laboratories. Developed in the Army's intensive language training programs during World War II, language laboratories multiplied rapidly in the postwar years and boomed under the financial impetus of the National Defense Education Act of 1958. The core of the language laboratory is the tape recorder, and as Carroll[128] has noted, "This device can present foreign language sounds and utterances with accuracy, fidelity, and endless patience and do so with great flexibility and ease of handling."

With its emphasis upon the prepared recorded sequence of stimuli with frequent opportunities for student responses, the language laboratory has close kinship to the programmed learning movement. Language laboratories are now an accepted part of the college scene, but experimental tests of their value are nonexistent so far as I can ascertain. At other educational levels there is scanty evidence, some of which is favorable. For example, Allen reports higher achievement for high school students with language laboratory experience, and Banathy and Jordan report favorable experience at the Army Language School.[129] Bauer[130] found that the success of the language laboratory depended upon the amount of supervision--a finding reminiscent of some of those in programmed learning and in independent study.

In view of the dearth of language laboratory research, it is interesting that research on other types of audiovisual aids has been encouraging. Carroll[131] reports successful use of an audiovisual teaching machine to teach the Arabic writing system, and the use of undergraduate student assistants to conduct laboratory sessions including films and acetate visuals has been successful in saving instructor time with some possible gain in achievement at Antioch College.[132]

Other imaginative uses of tape recorders are in presentation of oral questions in programmed teaching,[133] in dictation of comments about student papers,[134] in lecture-poster or slide presentation,[135] in an automated taped lecture, programmed question, film-strip presentation,[136] and in recording lectures prepared by students as a technique for developing student motivation and active integration of material.[137]

Telephones

Studies by Cutler, McKeachie, and McNeil[138] and by Davis[139] have shown that instruction can be effectively carried out over telephone circuits. The most imaginative use of the telephone is in enabling students to listen to and question a distinguished guest. The use of the telephone hour to interview the guest rather than to listen to him lecture maintains a high level of student interest and provides needed feedback to the guest.[140] In Hilgard's terms[141] this is an example of successful invention in which the actual practice of education is probably ahead of theory, for theory alone would probably not have suggested this technique nor predicted the high level of interest generated. But thus far no attempt has been made to evaluate learning resulting from this method.

XI. IMPLICATIONS FOR FURTHER RESEARCH

What are the implications for research? First, despite the common refrain that there is no longer any point in comparing one teaching method to another, we have seen that the cumulative weight of a number of studies provides fairly convincing evidence of relative effectiveness even though it is a rare single study that seems definitive. The common finding of "no significant difference" is not as empty as it once seemed. Teaching methods are differentially effective.

But the comparison of teaching methods gains richness of theoretical interest when some thought is given to what goals particular methods should achieve and when appropriate measures are used to differentiate achievement of these goals. Additional interest arises when measures of relevant student characteristics are used. Multivariate designs are becoming increasingly common (a desirable trend), but all too often the individual differences are included because convenient tests are available rather than because some thought has been given as to which individual differences are theoretically most likely to be relevant.

Studies comparing teaching methods over a semester have been the most common form of research on teaching. It is encouraging to find signs that our perspective is shifting to include studies of effects persisting after the final examination and to include processes intervening between the beginning and end of the semester. On the other hand, there are an increasing number of studies of cognitive processes deriving from studies in programmed learning. There are also a few studies of classroom processes involving day-to-day or week-to-week changes in patterns of interaction between students and teachers. To understand the changes produced by teaching we need to identify the dimensions of students' and teachers' feelings during a course; we need to look at the processes by which students take on or resist the instructor's goals for a course; we need to examine the shifting alliances, the competitive gambits, and the cooperative or collusive strategies students evolve in meeting the demands of the course. The research strategies used to study these questions may well be more naturalistic than those now used, but they need not be impressionistic. Studies of cognitive, affective, and social processes intervening between precourse and postcourse measures have great untapped potential for increasing our understanding of college teaching.

It has been natural that research on teaching effectiveness should focus on the influence of methods upon student learning.

But if we look on the college as a community of learners it becomes evident that research has almost completely neglected the effects of different teaching methods upon teachers--upon their motivation for teaching, upon their own learning as scholars and teachers, upon their self-percepts, and upon their status among their peers and in their own institution. For example, what is the effect upon the teacher of having the major part of his course on television tapes? And what is the effect upon the teacher of being chosen to do a telecourse himself?[144] Does a professor learn more about his field and his teaching skills from preparing and delivering a lecture or from planning and conducting a discussion? These are fascinating, unanswered, researchable questions.

Finally, we need more and more work on the evaluation of teaching. Our criterion measures are improving, but we still lack satisfactory measures of achievement of our most important educational goals. Moreover, there are still some researchers who confuse evaluation of students' achievement for the purpose of assigning grades with the more complete measures needed for evaluating teaching methods. In the latter case one does not avoid the inclusion of questions "unfair" to one group because they did not attend lectures or read beyond the textbook; likewise, one needs to include measures of attitudinal or motivational changes which are not usually considered appropriate bases for grading.

XII. CONCLUSIONS

Where do we stand today with respect to teaching methods? It is clear that there is no one best method for all goals, students, or teachers. Rather, the best method is a function of each of these variables.

When one looks at current learning theory, there seems to be a tremendous gap between it and current educational practice. But this is neither the fault of the learning theorist nor the educator. Educators are applying learning theory; the empirical wisdom of good teachers is generally consistent with learning theory so far as comparisons can be made. Learning theory cannot dictate educational practice because no learning theory now deals with the complex interactions of the many variables affecting classroom learning. The very constraints necessary for laboratory experimentation limit the applicability of the research to the classroom. As Hilgard has suggested,[142] however, learning theory can suggest directions for educational research. The programmed learning movement failed to reach its goals as rapidly as hoped because the jump from laboratory to school involved motivational and social-psychological variables which were controlled in laboratory studies. Notwithstanding, the research on programmed learning is proving to be enormously productive for education. No other stream of educational research has produced so many findings on issues both of theoretical and practical importance to education. As we have seen, theory is also beginning to have an impact upon research directions relevant to the traditional problems of college teaching. The generalization that psychological theory has dictates for teaching which could be immediately applied with great profit seems to be about as true as that theoretical chemistry has rules useful to a good cook; nevertheless, psychological theory can provide concepts that may be helpful to college teachers in analyzing and interpreting their experience.

Moreover, we do know more in the area of theory and research on classroom teaching than we are usually given credit for.[143] We have seen fairly convincing evidence that differing teaching methods do make a difference in learning if one analyzes the different goals of education. Other things being equal, small classes are probably more effective than large ones, discussions more effective than lectures, and student-centered discussions more effective than instructor-centered discussions for goals of retention, application, problem solving, attitude change, and motivation for further learning. Teaching methods are differentially effective for differing kinds of learning; thus, the teacher must make value decisions about what he wants to aim for as well as strategic decisions about his means to these goals.

We also have seen a good deal of evidence that different teaching methods work well for differing types of students. This too implies that a variety of methods should be used in a college and in a course. One would hope that each student would be "turned on" by some aspect of the course even though other aspects might be relatively unprofitable to him.

When we say that discussion is more effective than lecture in achieving problem-solving skills, there is always the implicit proviso "other things being equal," or even better "as usually practiced." One does not always have a choice as to whether a class will be small or large or even as to whether it can be taught by discussion or lecture. One is not thereby foredoomed to focus on lower-level objectives. I suspect that with imagination and planning any teaching situation can produce better than typical achievement of any educational goal. I have suggested that discussion helps develop problem-solving skills because students have an opportunity to practice problem solving in class. If these skills are important goals, an instructor in a lecture class could undoubtedly give students problem-solving practice (with feedback) either in the lecture itself or as written assignments. Research is needed on such differences in methodology within the major methods that have traditionally been studied.

One implication of these findings is that one should expect to find a variety of teaching methods used in a college and that teachers should develop a repertoire of skills. With increasing knowledge about their particular strengths, we should be better able to match means and ends, varying our procedures from day to day and minute to minute as our varying goals move in and out of the spotlight. We need to free the teacher not only by providing him with all the possible physical tools and facilities, but also by arming him with the skills necessary to make choices of the possible techniques.

All of this adds up to the notion that effective college teaching is a very complex business. The very complexity of the teaching situation is the source of its challenge to creative minds. Research can help to lay bare the deepest properties of our teaching while revealing to us more wonderful intricacies. As we gain in our understanding, our teaching will be illumined with new insight, delight, and mastery.

FOOTNOTES

1. Stanford Erickson, Director of the Center for Research on Learning and Teaching of the University of Michigan, gave me many helpful suggestions on an earlier draft of this paper. Preparation of the paper was also facilitated by the author's participation in the project sponsored by the U. S. Office of Education, Research Contracts O.E. No. SAE-8451 and O.E. No. 4/10-001 to W. J. McKeachie, J. E. Milholland, and Robert L. Isaacson. My co-workers, Drs. Robert Isaacson, John Milholland, and Richard Mann have offered helpful suggestions. Ruth Miller was an excellent bibliographic aid. Portions of this chapter are derived from a paper prepared by the author for the 1966 meeting of the American Council on Education.

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108. Monica Bainter, "A Study of the Outcomes of Two Types of Laboratory Techniques Used in a Course in General College Physics for Students Planning to be Teachers in the Elementary Grades." Unpublished doctoral dissertation, University of Minnesota, 1953.

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110. Sara Burkhardt, "A Study in Concept Learning in Differential Calculus." Unpublished doctoral dissertation, Columbia University, 1956.

111. This technique was used by the late Paul Fitts in teaching his course "Principles of Research Design" in the Department of Psychology, University of Michigan.

112. G. L. Hershey, L. V. Shepard, and J. D. Krumboltz, "Effectiveness of Classroom Observation and Simulated Teaching in an Introductory Educational Psychology Course." Journal of Educational Research, vol. 58, p. 233-36. 1965. In this study, participation in simulated teaching experiences was not significantly different in effect on knowledge, attitudes, and career plans from actual classroom observation (presumably a plus for simulation). See also J. A. Robinson, R. C. Snyder, L. F. Anderson, and Margaret Hermann, A Comparison of Simulation, Case Studies, and Problem Papers in Teaching Decision-making. Evanston, Illinois, Northwestern University, Cooperative Research Project

No. 1568, 1964. Here simulation was compared with case studies in a sophisticated study. Women high in need for power in the simulation groups developed more interest in the subject and read more than similar women in case study, and simulation tended to develop more interest generally according to three criteria. Learning of facts or principles was not significantly different.

113. For a detailed review, see McKeachie, "Research on Teaching at the College and University Level, op. cit. See also W. Schramm, "What We Know About Learning from Instructional Television." In Educational Television: The Next Ten Years. Stanford, The Institute for Communication Research, 1962. This study reports 13 significant differences favoring live teaching versus three favoring television.

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115. Siegel and Siegel, op. cit.

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126. R. E. Snow, J. Tiffin, and W. F. Seibert, "Individual Differences and Instructional Film Effects." Journal of Educational

Psychology, vol. 56, p. 315-26. 1965.

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131. J. B. Carroll, "Programmed Instruction and Student Ability." Journal of Programmed Instruction, vol. 2, p. 7-11. 1963.

132. "Experiment in French Language Instruction." Antioch College Reports, Yellow Springs, Ohio, 1960.

133. H. C. Mahan, "Adjunct Programming of the Basic Psychology Course for Oral Presentation Via Tape Recorder." Abstract of paper presented at the Western Psychological Association, Spring, 1966.

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135. R. E. Johnston, "Magnetic Recordings and Visual Displays as Aids in Teaching Introductory Psychology to College Students." Audio-Visual Communication Review, vol. 9, p. 1-46. 1961. Students in this experiment who were taught by the taped lectures

achieved less than those taught conventionally. Also see W. J. Popham, "Tape Recorded Lectures in the College Classroom." Audio Visual Communication Review, vol. 9, p. A28-A29. 1961. The same technique has also been in use at the Technical University of Berlin.

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137. N. J. Webb, "Student Preparation and Tape Recording of Course Lectures as a Method of Instruction." Psychological Reports, vol. 16, p. 67-72. 1965.

138. R. L. Cutler, W. J. McKeachie, and E. B. McNeil, "Teaching Psychology by Telephone." American Psychologist, vol. 13, p. 551-52. 1958.

139. K. E. Davis, "Do Students Learn From a Telephone Lecture?" Presented at American Psychological Association, September, 1963.

140. There are hints of this in both the Davis paper and in the Stephens College experience. J. A. Burkhart, "An Experiment to Determine the Values of Using Amplified Classroom Telephone Interviews with Significant Individuals to Enrich Certain College Courses." Final Report--Registry Form Title VII, File 250. Sponsored under the Provisions of the National Defense Act of 1958 (P.L. 85-864).

141. E. R. Hilgard, "Learning Theory and its Applications." In New Teaching Aids for the American Classroom, p. 19-26. Stanford, Institute for Communication Research, 1960.

142. In Theories of Learning and Instruction NSSE, p. 404. 63rd Yearbook, 1964. Also see A. Melton, "The Science of Learning and the Technology of Educational Methods." Harvard Educational Review, vol. 29, p. 96-106. 1959. Lumsdaine, ed., Student Response in Programmed Instruction, op. cit.

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144. C. R. Carpenter and L. P. Greenhill, "An Investigation of Closed-circuit Television for Teaching University Courses." Instructional Television Research Project No. 1, University Park, Pa., Pennsylvania State University, 1955. C. R. Carpenter and L. P. Greenhill, "An Investigation of Closed-circuit Television

for Teaching University Courses." Instructional Television Research Project No. 2, University Park, Pa., Pennsylvania State University, 1958. L. I. Grossman, I. I. Ship, and M. T. Romano, "Evaluation of Teaching and Television vs. Classroom Demonstration." *Journal of Dental Education*, vol. 25, p. 330-37. 1961. D. F. Kasten and W. F. Seibert, "A Study of Televised Military Science Instruction." Purdue University, Television Research Report No. 9, 1959. Hope L. Klapper, "Closed Circuit Television as a Medium of Instruction at New York University." New York, New York University, 1958. A. R. Lepore and J. D. Wilson, "An Experimental Study of College Instruction Using Broadcast Television." Instructional Television Research, Project No. 2, San Francisco, San Francisco State College, 1958. F. G. Macomber and L. Siegel, "Experimental Study in Instructional Procedures." Progress Report No. 1. Oxford, Ohio, Miami University, 1956.

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1. Bartz, W. H., and C. L. Darby, "A Study of Supervised and Nonsupervised Programmed Instruction in the University Setting." Journal of Educational Research, vol. 58, p. 208-11. 1965. (Purdue University.)

The purpose of this study was to compare supervised with nonsupervised completion of programed textbooks and to compare programed instruction with formal instruction. Forty-three university students were assigned to one of four groups: (1) formal instruction, (2) supervised programed instruction, (3) nonsupervised programed instruction, and (4) no instruction. Although results favored formal instruction and supervised programed instruction over nonsupervised programed instruction, the differences may be due to bias in the sample, since the former two groups were regularly enrolled and the latter group was not.

2. Caro, P. W., "The Effect of Class Attendance and 'Time Structured' Content on Achievement in General Psychology." Journal of Educational Psychology, vol. 53, p. 76-80. 1962. (University of Tennessee.)

This study compared achievement of students who attended regular lecture-discussion classes in introductory psychology with those who did not attend such class sessions throughout the term, and investigated student achievement under different amounts of time structure, as determined by the schedule of testing. Subjects were 335 college students. Students who had been in independent study performed as well on an objective final examination as those in the conventional class situation, and time-structured content was ineffective as a determiner of student achievement. Even though the results were negative, this is a good example of the use of a factorial design to study an insightful hypothesis. Although only one criterion test was used, 20 items were on portions of the text emphasized in the lecture and scores on these items were analyzed separately, a desirable procedure.

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*Unless otherwise noted all articles listed are written at a level comprehensible by a college professor in any field, although most are directed to an audience of college teachers in the subject matter field of the author.

3. Center for Research on Learning and Teaching (University of Michigan), Memo to the Faculty. Ann Arbor, Mich. (Serial.)

This series of four-to-six-page memos edited by Stanford Erickson includes helpful summaries of research evidence and sensible counsel for faculty members on topics relevant to college teaching. The most recent Memo, No. 17, deals with class size.

4. Eash, M. J., and C. M. Bennett, "The Effect of Class Size on Achievement and Attitudes." American Educational Research Journal, vol. 1, p. 229-39. 1964. (Ball State Teachers College.)

This study was designed to compare some of the attitudes and perceptions, as well as the achievement, of students in large and small classes. College students taking general psychology in the years 1960-1962 and for whom entrance-test data were available composed the experimental and control groups. Students taught a pattern of large lecture class plus small 15-student discussion group performed better on objective measures of achievement than students taught in conventional lecture-discussion classes ranging in size from 30 to 50. Interview data dealt with students' perceptions of their own learning and of the instructor. A very good study.

5. Eckert, Ruth E., and D. C. Neal, "Teachers and Teaching." Review of Educational Research, vol. 35, p. 304-17. 1965.

This article, which is concluded with a most useful bibliography, briefly reviews recent work on staffing and teaching practices. Problems, such as recruitment, preparation, orientation and in-service training, status and services, and satisfactions of college teachers are considered, and college teaching topics such as concepts and theories of teaching methods and student and teacher characteristics are also included. A section on "next steps in research" concludes the article. Dr. Eckert is one of the wisest scholars in this field and this chapter is an excellent source for the reader desiring an overview of the contemporary scene.

6. Feldhusen, J. F., "The Effects of Small and Large Group Instruction on Learning of Subject Matter, Attitudes, and Interests." Journal of Psychology, vol. 55, p. 357-62. 1963. (Wisconsin State College.)

Twenty-two students enrolled in a large class of 72 students in educational psychology were matched on the basis of scores on an educational psychology achievement test and scores on a mental ability test with a group of 22 students enrolled in a small class of 28 students. Students in the large group were taught with lectures and demonstrations three times a week and in two groups for the fourth meeting. Students in the small group also met four times a week for the same lectures and demonstrations. Terminal measures revealed no significant differences in subject matter attainment, in interest in teaching, and in attitudes toward children and teaching, although results tended to favor the smaller class. Unfavorable attitudes of students toward the larger instructional grouping were noted. This study used a desirably diverse set of outcome measures. By controlling method, size was clearly the independent variable, but the size-method interaction may be so crucial that studies on class size should not attempt to keep methods the same in both large and small classes.

7. Friedman, H. L., and D. B. Orr, "Comprehension of Speeded Speech as a Function of Practice." Presented at American Psychological Association, September 3, 1965.

This paper's primary concern was with the effects of practice in listening to speeded speech on the listener's ability to comprehend such speech. The paper explains and describes three different experiments designed to examine the above. Subjects used in the experiments were freshmen and sophomores chosen from local universities in the Washington area. Results showed that experimental groups, who were given practice in listening, demonstrated a significant improvement in performance on the repeated passage presented at 475 words per minute. The control group did not. An intriguing idea.

8. Hartman, F. R., "Single and Multiple Channel Communication: A Review of Research and a Proposed Model." Audio-Visual Communication Review, vol. 9, p. 235-62. 1961.

This review deals with three channels of information presentation--pictorial, auditory-verbal, and print--and the effects of these channels when used in combination to present information. The paper suggests a theoretical formulation by which the diverse results set forth in the literature may be better knitted together and also suggests clarifying experiments where reconciliation is difficult. The review is organized into four sections with the first section reviewing experiments comparing one channel with another, while the second, third, and fourth sections deal with the principal topic. Major generalizations are drawn and implications for communicators are clearly considered. A complete bibliography is included. A scholarly job.

9. Hatch, W. R., and Ann Bennet, "Effectiveness in Teaching." New Dimensions in Higher Education, No. 2 (U. S. Department of Health, Education, and Welfare). 1960.

The "New Dimensions" series provides wise and readable reviews of the current situation on a number of issues in higher education. Issue Number 2 is particularly relevant to the topic of this chapter.

10. Hershey, G. L., L. V. Shepard, and J. D. Krumboltz, "Effectiveness of Classroom Observation and Simulated Teaching in an Introductory Educational Psychology Course." Journal of Educational Research, vol. 58, p. 233-36. 1965. (Michigan State University.)

The purpose of this study was to compare experimentally two methods of teaching the relationship of psychological knowledge to instructional practices: (1) off-campus trips for public school classroom observation; (2) on-campus simulated teaching experiences. Some 282 Michigan State students were assigned to one of the two treatment groups. Course grades, final exam.scores, attitudes about teacher-pupil relationships, career plans, the ability to apply psychological principles, or general course satisfaction did not reveal significant differences between the treatments. However, subjective ratings showed that the simulated teaching experience was rated more helpful in mastering certain teaching skills, while it was felt that the classroom observation had had more general benefit on their development as teachers. The five instructors did have significantly different effects upon attitudes. A sound study.

11. Hill, R. J. A Comparative Study of Lecture and Discussion Methods. Fund for Adult Education, 1960.

The adult education course "Ways of Mankind" was taught in 13 classes--10 small group discussions, two small lectures, and one large lecture. All groups used the "Ways of Mankind" recordings. A good experimental design and comprehensive evaluation compared the effectiveness of lecture and discussion and large vs. small groups. Differences between the groups in effectiveness were small despite a very thorough analysis.

The only major difficulty in the study was the 37 per cent dropout rate from beginning to end. This was controlled in the analysis, but an interesting note was that students with deviant attitudes were more likely to drop out if they were in discussion sections. A very good study.

12. Krumboltz, J. D., "The Nature and Importance of the Required Response in Programmed Instruction." American Educational Research Journal, vol. 1, p. 203-9. 1964. (Stanford University.)

This study investigated two questions about the role of the response in programmed instruction: (1) To what extent does the content of the required response affect learning and retention of the material? and, (2) To what extent does the requirement of any response add to the learning and retention value of the program? There were 53 undergraduates and 67 graduate students randomly assigned to four groups who took the following programs: (1) a program on educational measurements requiring an important concept in the response, (2) the same program requiring a minor word as a response, (3) the same material written as textbook prose, and (4) a program covering different topics (control group). Parallel forms of a criterion test were administered. The key concept and "textbook prose" groups were superior to the "trivial word" groups. A good study including measures both two days and two weeks after learning.

13. Krumboltz, J. D., and W. W. Yabroff, "The Comparative Effects of Inductive and Deductive Sequences in Programmed Instruction." American Educational Research Journal, vol. 2, p. 223-35. 1965.

The purpose of this study was to determine the teaching efficiency of inductive and deductive sequences of instruction with varying frequencies of alternation between problem solving and rule stating. The study sample was made up of 272 upper-division students at the University of Minnesota. These students responded to a 117-frame program on test interpretation in a mean time of 100 minutes. Neither method of teaching nor frequency of alternation produced significant differences in scores on a criterion test. The inductive group made errors on the program, took less time to answer test questions on rules, but liked their method of instruction less than the deductive group liked theirs. This study is a good illustration of the use of programed learning to study a question of theoretical as well as practical interest.

14. Lancaster, O. E., K. V. Manning, M. W. White, and other members of the Physics Department, Pennsylvania State University,

"The Relative Merits of Lecture and Recitation in Teaching College Physics." Journal of Engineering Education, vol. 51, p. 425-33. 1961.

In order to test the achievement made in instruction by lecturing with that of instruction by recitations, a physics course for engineers was given by three distinct procedures: (1) three recitations, one lecture, and one practicum per week; (2) two recitations, two lectures, and one practicum per week; and (3) one recitation, three lectures, and one practicum per week. All groups followed the same general outline of subject matter. Achievement, as measured by three one-hour tests and one two-hour final, increased significantly as the number of recitations increased and the number of lectures decreased. Students felt they profited more from recitation and that they would profit more from more recitation. This study makes good use of analysis of covariance to control for achievement in a preceding physics course.

15. Leton, D. A., "An Evaluation of Course Methods in Teaching Child Development." Journal of Educational Research, vol. 55, p. 118-22. 1961. (University of California, Los Angeles.)

This study compared the relative efficiency of three different methods of college teaching: (1) lecture; (2) case-centered, and (3) group-centered. It was also designed to determine whether students' attitudes toward children are measurably influenced by a course in child development. The group-centered classes differed in homogeneity of attitudes toward teaching. The Minnesota Teacher Attitude Inventory and Shoben's Parent Attitude Survey were administered as pre- and post-tests to the 145 students enrolled. Midterm and final examination scores were also used in the evaluation. Achievement was not significantly affected by teaching method. Favorable changes in attitudes toward children occurred, but differences between groups were not significant. A good study.

16. Lublin, Shirley, "Reinforcement Schedules, Scholastic Aptitude, Autonomy Need, and Achievement in a Programmed Course." Journal of Educational Psychology, vol. 56, p. 295-302. 1965. (Pennsylvania State University.)

Using 219 university students, this study was designed to investigate three questions: (1) whether or not different schedules of reinforcement are differently related to achievement in a programed course, (2) whether or not programed instruction tends to reduce individual differences in performance due to aptitude, and (3) whether autonomy need is related to achievement in a programed course.

Measures used were (1) errors made on a criterion test on the program, (2) aptitude scores from the Pennsylvania State University aptitude test, and (3) autonomy need scores from Edwards Personal Preference schedule. Results showed the following: (1) the control group (no reinforcement) and the variable ratio (50 per cent) group scored significantly higher than the continuous reinforcement group, (2) above average aptitude subjects scored significantly higher than below average aptitude subjects, and (3) low-autonomy need subjects scored significantly higher than high autonomy need subjects.

This is a good factorial design to study potential interactions between teaching method and student characteristics. The major limitation of the study is restriction of the criterion to review items chosen from the program. However, none of the items duplicated items in the program.

17. McQueen, R., "An Experiment in the Teaching of General Psychology." Journal of Educational Research, vol. 55, p. 372-75. 1962. (University of Nevada.)

This study assessed the effects of changing both the number of formal instructor-student contact hours and the amount of required reading. Six sections of general psychology students constituted the study groups. Control groups met three times a week in lecture-discussion classes and read a textbook. Experimental sections were assigned the same basic textbook in addition to two volumes of selected readings in general psychology. They met once a week. Performance of the experimental group was significantly poorer on the final examination than that of the conventionally taught control group. This held true for students of differing levels of ability.

Because the criterion measure was a graded examination on materials common to both groups, no assessment was made of the possible additional learning from the supplementary readings. This and other additional criteria measures would have been useful.

18. Novak, J. D., "The Use of Labeled Photomicrographs in Teaching College General Botany." Science Education, vol. 45, p. 119-21. 1961. (Purdue University.)

This study was an attempt to measure the effect of labeled photomicrographs, supplied in addition to the regular outline drawings in the laboratory manual, on college student achievement in a general botany course. Forty-three students were randomly divided into two groups: (1) those who did laboratory work with outline drawings and labeled photomicrographs, and (2) those who did laboratory work with outline drawings provided in the laboratory guide. A statistical test of differences between groups was not carried out, but it appears that the photomicrographs made a significant contribution to skill in identifying structure. This is a good example of a design in which each group serves as its own control, a design which has much utility for research on college teaching but which is seldom used.

19. Siegel, L. and Lila Siegel, "The Instructional Gestalt: A Conceptual Framework and Design for Educational Research." Audio-Visual Communication Review, vol. 12, p. 16-45. 1964. (Miami University.)

The first section of this paper advances the idea that the pattern of educational investigations is defective in three ways: (1) criteria are often inappropriate or contaminated, (2) assumptions of homogeneity and independence between "experimental" and "control" conditions are met only when these conditions are grossly conceived, and (3) the results reflect masking and cancellation effects. In the second part of the article an instructional Gestalt is proposed as a methodological framework for educational research focusing upon the interactive nature of learner, instructor, and environmental and course variables constituting the instructional setting. An illustrative study was presented within this framework indicating the kinds of hypotheses resulting from studies within the framework. A useful bibliography is included. One of the most important papers in this field in recent years.

20. Smith, N. H., "The Teaching of Elementary Statistics by the Conventional Classroom Method Versus the Method of Programmed Instruction." Journal of Educational Research, vol. 55, p. 417-20. (U. S. Air Force Academy.)

This study compared conventional methods of classroom instruction with programed instruction used in a classroom with the instructor available for individual help. The subjects were 128 freshman cadets at the U. S. Air Force Academy who attended mathematics class for 12 lessons and were given a one-hour final test immediately after the completion of the course. Neither the conventional method nor programed instruction was superior. Students liked the program-tutorial method. Less time was required for the program, an outcome which was true for each ability group. Essentially the programed learning group was able to do most of its studying in the classroom rather than out of class. A well-controlled study.

21. Snow, R. E., J. Tiffin, and W. F. Seibert, "Individual Differences and Instructional Film Effects." Journal of Educational Psychology, vol. 56, p. 315-26. 1965. (Purdue University.)

The purpose of this study was to determine if and how selected attitude, temperament, past experience, and aptitude variables might be differentially related to learner performance under different methods of teaching the same subject matter. Some 437 college students were divided between film and live physics lecture demonstrations. Immediate and delayed recall material were applied. Results indicated that attitude toward instructional films, ascendancy, responsibility, numerical aptitude, verbal aptitude, past experience with entertainment films, and past use of college library instructional films interacted significantly with instructional treatments, primarily on the immediate-recall criterion. Attitudes toward entertainment films and toward physics, emotional stability, sociability, total personality self-evaluation, academic achievement, and unspecified past experience with instructional films did not interact with instructional treatments. This is an excellent example of the sort of study of interactions of teaching methods and student characteristics advocated in the body of this chapter.

22. Solomon, D., L. Rosenberg, and W. E. Bezdek, "Teacher Behavior and Student Learning." Journal of Educational Psychology, vol. 55, p. 23-30. 1964.

This paper attempted to identify significant dimensions of teacher behavior through factor analysis of broadly selected items of teacher behavior, measured in natural settings, and the analysis of the relationships of these dimensions to students' learning. The classroom behavior of 24 teachers of evening college courses in introductory American Government was measured with tape recordings and observer ratings of two class sessions, student descriptive questionnaires, and teacher questionnaires. It was then factor analyzed. Learning of facts was significantly related to teacher "clarity, expressiveness, and to lecturing," while gains in comprehension related significantly to teacher "energy, flamboyance," and a moderate position on a permissiveness versus control continuum. An excellent study.

23. Thomas, E. J., and C. F. Fink, "The Effects of Group Size." Psychological Bulletin, vol. 60, p. 371-85. 1963.

This study formulates generalizations about the effects of group size (face-to-face groups ranging in size from two to 20 members) in which behavior was studied directly by observations, questionnaires, or interviews. It is a critical review and analysis of research methodology and problems relating to the subject, and it contains several recommendations for future research on group size. A useful bibliography is included.

24. Webb, N. J., "Student Preparation and Tape Recording of Course Lectures as a Method of Instruction." Psychological Reports, vol. 16, p. 67-72. 1965. (St. Norbert College.)

The problem of this study was to test the effectiveness of having students prepare and tape-record course lectures as a method of instruction. Seventy-one students in four separate psychology courses learned by the student-lecture method, and their course achievements were compared with those of controls of similar ability and training who learned with the same instructors using traditional methods. The results indicate that the student-lecture method offers considerable promise for improving the quality of student learning. However, the general applicability of the findings is restricted by the exploratory nature of the research. An interesting idea and a good example of how worthwhile research on teaching can be carried out in a small college.

25. Williams, Joanna P., "Comparison of Several Response Modes in a Review Program." Journal of Educational Psychology, vol. 54, p. 253-60. 1963. (University of Pennsylvania.)

The purpose of this experiment was to compare the effectiveness of programs which differ in the extent of participation required of a student. A program was administered to 128 college students in four versions which varied in response mode: (1) constructed response, standard format; (2) multiple choice, choice from two items and the correct answer found on the following page; (3) emphasis, each item as a complete statement with the important word underlined, no answer pages; (4) reading, each item as a complete statement, no underlining, no answer pages. Results ordered the groups in terms of learning efficiency (as measured by performance on an objective test and training time) as follows: emphasis (most efficient), reading, multiple choice, and constructed response. Performance varied with aptitude. A nicely designed study. Unfortunately, the essay test criterion was not analyzed because of low scorer reliability.

REACTIONS

In order for this second series of "New Dimensions in Higher Education" to better serve the needs of colleges and universities throughout the nation, reader reaction is herewith being sought. In this instance, with respect to New Developments In Teaching, the following questions are asked:

1. Can you suggest other completed research, the results of which would add significantly to this report?
2. What problems related to this subject should be given the highest priority, in terms of further research?
3. What helpful suggestions do you have for institutions or individual faculty members who are interested in the improvement of instruction?
4. What has your institution done, or what does it propose to do, to encourage effective teaching?
5. What can the United States Office of Education do to help colleges and universities help themselves?

Kindly address reactions to:

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